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SENSOR SYSTEM AND METHOD FOR ITS MANUFACTURE

The present invention relates to a sensor system, particularly for determining the relative humidity in air, as defined in Claim 1, and a method for manufacturing such a sensor system as defined in Claim 7.

Such sensor systems are often used for determining the relative humidity, for instance, in automotive air conditioners, in household appliances or in copier machines, and are consequently used in great quantities. As a cost-effective type of construction for the sensors used therein, so-called thin-film sensors are often used, whose functioning method is based, for example, on a capacitive measuring principle. The thin-film sensors are usually produced in planar fashion, i.e., all active films as well as the contacting areas of the thin-film sensors are accommodated on one surface of the thin-film sensors. Generally no coatings are then located on the back side of such thin-film sensors.

To manufacture a functional sensor system in as automated a manner as possible, printed circuit boards are fitted with these sensors and appropriately electrically contacted.

EP 1 046 030 B1 describes a sensor system of this kind, the sensitive region of the sensor being disposed at an opening in the printed circuit board. This type of construction has the disadvantage that, during operation of the sensor system, both sides of the printed circuit board are constantly exposed to the humidity to be measured. Moreover, additional production costs result from the provision of the opening in the printed circuit board.

The U.S. Patent 4,942,364 describes a resistively acting moisture sensor, in which the moisture-dependent electrical resistance of a suitably prepared non-woven material is determined. This moisture sensor has two connecting wires for insertion into an electric circuit. The connecting wires are bonded to the non-woven material with the aid of a conductive adhesive. Such sensors have the disadvantage that they are not, or are just barely suitable for automatic assembly on a printed circuit board.

Therefore, the object of the present invention is to provide a sensor system which is producible with low manufacturing expenditure, and which exhibits great robustness, as well as good measuring accuracy. In the same way, the present invention provides a cost-effective and reliable method for manufacturing a sensor system of this kind.

This objective is achieved according to the present invention by the features of Claim 1 and Claim 7, respectively.

According to the present invention, the contacting area of a thin-film sensor is electrically connected to a contact pad on a printed circuit board using a conductive adhesive. In so doing, the sensor is placed in such a way relative to a surface of the printed circuit board that the contacting area is disposed on a surface of the thin-film sensor facing away from the specified surface of the printed circuit board.

As conductive adhesive, adhesives are considered here which have a comparatively low electrical bulk resistance (advantageously less than 10^{-1} Ωcm, particularly less than 10^{-2} Ωcm). Preferably, conductive adhesives are used here which are filled with electroconductive particles and have a proportion of filler of more than 50% by weight, particularly more than 66% by weight.

In one preferred embodiment of the present invention, provided between the thin-film sensor and the printed circuit board is a mounting adhesive which, on one hand, simplifies the mounting operation and increases the operational reliability of the method, and on the other hand, also ensures good thermal coupling of the thin-film sensor to the printed circuit board. In this connection, it is especially favorable if the mounting adhesive exhibits high thermal conductivity, particularly greater than 0.3 W/(m·K). The mounting adhesive advantageously has thermal conductivity greater than 0.5 W/(m·K).

Advantageous developments of the present invention are found in the dependent claims.

Further details and advantages of the sensor system according to the present invention and of the corresponding manufacturing method are derived from the following description of an exemplary embodiment with reference to the attached figures, in which

Figure 1	shows a top view of the sensor system according to the present invention;
Figure 2	shows a section X-X through the sensor system of the present invention;
Figures 3a to 3d	in each case show a top view of the sensor system of the present invention after different manufacturing steps for clarifying the manufacturing method.

Figure 1 shows a top view of a sensor system according to the present invention. The sensor system is made up of a thin-

film sensor 1 and a printed circuit board 2, of which only a segment is shown here.

Thin-film sensor 1 is used for measuring the relative air humidity, and is based on a capacitive functional principle. Thin-film sensor 1 includes a substrate 1.7, on whose surface Z a base electrode 1.3 (see Figure 2), made of gold in the example shown, is applied. In the exemplary embodiment, substrate 1.7 is made of glass. Base electrode 1.3 is electrically connected via a conductor track 1.2 to a contacting area 1.1a. Both conductor track 1.2 and contacting area 1.1a are located on surface Z of substrate 1.7. A moisture-sensitive polymer 1.4 is applied over base electrode 1.3 in a sensitive region of thin-film sensor 1. Applied on this moisture-sensitive polymer 1.4 is a porous moisture electrode 1.5 which is in electrical contact with a further contacting area 1.1b on substrate 1.7 via a connecting electrode 1.6. Thus, on one hand, thin-film sensor 1 has surface Z having the sensitive region and contacting areas 1.1a, 1.1b, and on the other hand, has a passive side or back side opposite surface Z, on which no coating of substrate 1.7 whatsoever was carried out.

Printed circuit board 2 has a surface A on which conductor tracks 2.2 and contact pads 2.1a, 2.1b, here in the form of thin, electroconductive copper layers, are applied. Thin-film sensor 1 is placed in the sensor system in such a way relative to surface A of printed circuit board 2 that surface Z of thin-film sensor 1, which also has the sensitive region, is facing away from surface A of printed circuit board 2. That is to say, surface A of the printed circuit board and surface Z of thin-film sensor 1 are thus aligned essentially parallel to each other, but lie in different geometric planes.

A layer formed by a mounting adhesive 4 is located in the region between thin-film sensor 1 and printed circuit board 2. Mounting adhesive 4 is made of a polymer matrix and fillers, silver particles in the example shown, so that its thermal conductivity at 0.75 W(m·K) is comparatively great.

To transmit sensor currents from thin-film sensor 1 to printed circuit board 2, contacting area 1.1a of thin-film sensor 1 and contact pad 2.1a of printed circuit board 2 are electrically and mechanically interconnected by a conductive adhesive 3. Conductive adhesive 3 thus adheres both to contacting area 1.1a of thin-film sensor 1 and to contact pad 2.1a of printed circuit board 2, so that electrical voltages or currents are transmittable via conductive adhesive 3.

In this type of sensor, the change in capacitance of the sensitive region as a result of water adsorption of moisture-sensitive polymer 1.4 is used as a measured quantity. The resulting currents conducted via conductive adhesive 3 are then evaluated on printed circuit board 2.

To manufacture the sensor system of the present invention, according to Figure 3a, first of all a printed circuit board 2 is made available, on which conductor tracks 2.2 and contact pads 2.1a, 2.1b are already applied on surface A.

After that, in a first step S1, mounting adhesive 4 is applied on surface A of printed circuit board 2 in the region of the later contact area, thus here between the two contact pads 2.1a, 2.1b (Figure 3b). Immediately after the application of mounting adhesive 4, the area moistened by mounting adhesive 4 is smaller than the area of substrate 1.7 of thin-film sensor 1.

In a further step S2, as shown in Figure 3c, thin-film sensor 1 is placed relative to printed circuit board 2. In so doing, thin-film sensor 1 is arranged in such a way that surface Z of thin-film sensor 1, on which contacting areas 1.1 are disposed, is facing away from surface A of printed circuit board 2. In other words, the passive, non-sensitive side, thus, the back side of thin-film sensor 1 is joined, that is, adhered to printed circuit board 2. The amount of mounting adhesive 4 was apportioned in step S1 in such a way that, after thin-film sensor 1 has been placed on printed circuit board 2, no mounting adhesive 4 is pressed over the edge of thin-film sensor 2, i.e., no mounting adhesive 4 emerges laterally from the joint gap or, for instance, covers contact pads 2.1a, 2.1b as a result of pressing thin-film sensor 2 onto printed circuit board 2. It is thus ensured that after step S2, the position of thin-film sensor 1 on printed circuit board 2 is fixed.

In the following step S3, a conductive adhesive 3 is applied at a first adhesive location onto contact pad 2.1a and contacting area 1.1a. The volume of conductive adhesive 3 at this adhesive location is apportioned in such a way that conductive adhesive 3 touches both contacting area 1.1a and contact pad 2.1a, and after conductive adhesive 3 has hardened, adheres to these two locations. In this way, an electrical connection is produced between contact pad 2.1a and contacting area 1.1a. Since contact pad 2.1a and contacting area 1.1a are in two different geometric areas parallel to each other, conductive adhesive 3 is disposed around an edge of thin-film sensor 1. Analogously, contact pad 2.1b and contacting area 1.1b are interconnected by conductive adhesive 3 with a second adhesive location, so that after step S3, a sensor system according to Figure 3d is available.

On one hand, the use of a mounting adhesive 4 mechanically relieves the adhesive bond of conductive adhesive 3. On the other hand, the layer of mounting adhesive 4 ensures good thermal coupling of thin-film sensor 1 to printed circuit board 2, particularly since, as already mentioned, mounting adhesive 4 exhibits high thermal conductivity. This good thermal coupling is particularly advantageous when a temperature sensor is arranged on printed circuit board 2, so that virtually no temperature gradient exists between the temperature sensor and thin-film sensor 1, which is of great importance for the measuring quality, especially when measuring the dew point.

Due to the type of construction described, the sensor system may now be used in such a way that only one surface of printed circuit board 2, namely, surface A, is exposed to the moist air. Therefore, this aspect opens up possibilities for manufacturing such printed circuit boards 2 more cost-effectively, and increases the robustness of a sensor system of this kind.